Down the rabbit hole: Investigating disruption of the information encountering process

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Abstract

Information encountering (IE) often occurs during active information-seeking and involves passively finding unsought, unexpected information that is subjectively considered interesting, useful or potentially useful. While the idealized IE process involves engaging with information after noticing it (e.g. by examining it, conducting follow-up seeking to determine usefulness, then using or sharing it), the process can be disrupted - resulting in missed opportunities for knowledge and insight creation. This study provides a detailed understanding of when and why the process can be disrupted. Think-aloud observations and Critical Incident Interviews were conducted with fifteen Web users, focusing on examining when they encountered information but did not engage with it. Factors that discouraged engagement and simultaneously encouraged participants to return to active, goal-directed information-seeking by disrupting the IE process were identified. These factors individually and collectively demonstrate IE can instigate a highly uncertain cost-benefit trade-off, sometimes resulting in encounterers being cautious by returning to 'less risky' active seeking. Design suggestions are made for reducing the uncertainty of deciding whether to engage with encountered information and making it easier to return to the active seeking task if disruption occurs.

Introduction

Information encountering (Erdelez, 1999), IE for short, is a type of serendipitous information acquisition that involves passively finding *unexpected* information that was *not purposively sought* and is considered subjectively *interesting, useful or potentially useful*. IE is usually embedded in active information-seeking, when looking for information on a partly or seemingly unrelated topic or information with a vague or no specific aim (Makri et al., 2015). Sometimes encountered information can be highly impactful (e.g. a research article from another discipline that changes your conception of your own), other times it can simply be casually interesting (e.g. a news article). While IE often results in using the encountered information, sometimes the information does not turn out to be as useful or interesting as first thought (Makri et al., 2017), constraining use.

The entire IE process involves *noticing* an informational *stimulus, stopping* or *suspending* the active information-seeking task, *acquiring* and *examining* the encountered information, *exploring* the information (by conducting follow-up information-seeking), then *capturing*, *using* or *sharing* it (Erdelez 2004, Awamura, 2006; Jiang et al., 2015). However, the idealized process can be disrupted if the encounterer decides *not* to engage with the encountered information by examining or exploring it, potentially resulting in missed opportunities for knowledge and idea creation. While some research has examined the IE process and identified influencing factors, no known prior research has provided a detailed understanding of *when* and *why* the process can be disrupted. This understanding can inform the design of digital IE environments that minimize and mitigate the effects of disruption.

Think-aloud observations and Critical Incident interviews were conducted with fifteen Web users, focusing on where they encountered but did not engage with information. Examples of disruption at various process stages were noted. Factors were identified that discouraged encounterers from examining or exploring the information and simultaneously encouraged them to return to goal-directed, active information-seeking. These factors individually and collectively demonstrate that information encounters can instigate a highly uncertain cost-benefit trade-off that can result in encounterers being cautious and returning to the more certain activity of active information-seeking.

In ‘background,’ the term ‘information encountering’ is introduced and related concepts discussed. Existing literature on how it can be influenced is reviewed. Then our data collection and analysis approaches are explained and justified, findings are reported and discussed, and design suggestions made.

Background

Nature and scope of information encountering

‘Information encountering’ was first used by Erdelez (1997) to describe a specific type of serendipitous information acquisition: *“an instance of accidental discovery during an active search for some other information*” (Erdelez, 2005, p.180). Information encounters are ‘accidental’ as information is unexpectedly found while looking for partly or seemingly-unrelated information; the encountered information is not sought in the relation to the active search. Although IE occurs during *active* information-seeking, information is encountered *passively*, with little or seemingly no effort. It is therefore characterized by the encounterer’s *low expectation of and involvement in* finding encountered information (Erdelez, 1997). Several researchers have used the concept to frame empirical studies into aspects of the phenomenon (e.g. Awamura, 2006; Tsai and Huang, 2010; Jiang et al., 2015; 2018, Makri et al., 2015; 2017; Panahi et al., 2016).

The broader concept of serendipitous information acquisition has been referred to by various names, including opportunistic discovery of information (Erdelez, 1997; Pálsdóttir, 2011), serendipitous information encountering (McKenzie, 2003; Foster and Ford, 2003), incidental information acquisition (Heinström, 2006; Williamson, 1998) and accidental information discovery (Race and Makri, 2016). All try to capture the essence of the same underlying phenomenon; the passive acquisition of unexpected information that was not purposively sought and is considered interesting, useful or potentially useful by the acquirer.

The abundance of confusingly-similar terms might explain why some researchers (e.g. McKenzie, 2003; Bawden, 2011, Makri et al., 2015; 2017), prefer to regard IE as synonymous to ‘serendipitous information acquisition,’ and therefore adopt a broader scope than originally defined by Erdelez. This extends beyond information unexpectedly found during active search to include information found when: actively seeking information by *other means* than *search* (e.g. browsing; Makri et al., 2015; 2017, monitoring; McKenzie, 2003; O’Brien and Toms, 2008; Dantonio et al., 2012), actively seeking information *without a particular aim* (undirected seeking) (O’Brien and Toms, 2008; Bawden, 2011; Jiang et al., 2015; Makri et al., 2015) and when *not seeking information at all*, i.e. non-purposive acquisition (McKenzie, 2003). Indeed, in McKenzie’s (2003) model of information practices, non-directed monitoring is considered an *undirected*, *non-purposive* and *passive* mode of information acquisition that involves *“serendipitous encounters in unexpected places”* (p. 26). We advocate expanding the scope of ‘information encountering’ to cover all forms of serendipitous information acquisition (i.e. passive acquisition of information considered unexpected and interesting, useful or potentially useful). However, this research examined IE *within its original scope* – as embedded during active information-seeking.

The information encountering process

The IE (Erdelez, 2000; 2004; refined by Awamura, 2006; Jiang et al., 2015, figure 1) involves:

- **Noticing** an informational stimulus (e.g. a hyperlink to a webpage or article);
- **Stopping** or **suspending** the active information-seeking task;
- **Acquiring** and **examining** the content of the encountered information (e.g. the page or article itself) to determine its interestingness, usefulness or potential usefulness;
- If considered potentially useful, **exploring** the information (by conducting follow-up information-seeking to determine its actual usefulness);
- **Capturing** interesting, useful or potentially useful content;
- **Using** the information (if considered useful for oneself);
- **Sharing** the information (if considered interesting or (potentially) useful for someone else);
- **Resuming** the active information-seeking task or **abandoning** it (either with or without starting a new task).

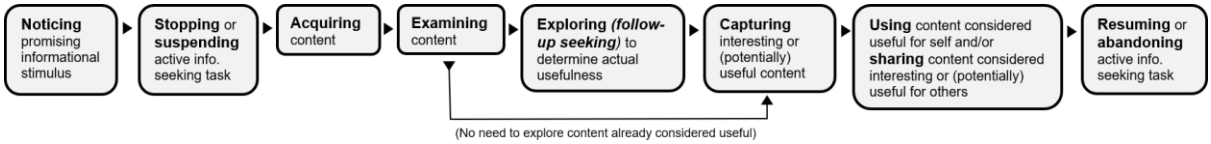

Figure 1: The information encountering process (adapted from Erdelez, 2004; Awamura, 2006; Jiang et al., 2015)

This is an *idealized* process as it can be inhibited from the outset, for example by stress, mood or time pressures preventing noticing (McCay-Peet and Toms, 2010; Jiang et al., 2015). It can also potentially be *disrupted* at any of the stages post-noticing. For example, even if a stimulus is noticed, the person may not stop to examine or explore it. Experimental findings demonstrate stimuli are often ignored when conducting an information-seeking task considered urgent or important (Erdelez, 2004; André et al., 2009; Toms and McCay-Peet, 2009).

Factors influencing information encountering

Although there has been 'sporadic' discussion of potential influencing factors (Jiang et al., 2015), few studies have expressly focused on examining how IE and serendipitous information acquisition more broadly can be influenced. Existing work is reviewed here.

The most discussed influencing factor is *time*. IE can be a 'stitch in time' (Erdelez, 1999), delivering information passively rather than through more effortful active seeking. However, often more time is required to explore encountered information through follow-up information-seeking, therefore IE can potentially *cost* time overall. The additional benefit of the unsought information may, however, outweigh this extra cost.

Actual or perceived *time pressure* influences ability to notice and willingness to examine and explore encountered information. Greater willingness is demonstrated during leisure versus work-related active seeking tasks (Jiang et al., 2015). Time is one of several pressures that act as a 'serendipity filter,' discouraging follow-up *"due to the pressing need to find what they were originally seeking"* (McBirnie, 2008, p.608). Time pressure can also restrict exploration of recommendations in controlled settings (Toms and McCay-Peet, 2009). In a diary study of value creation from IE, several participants did not feel they had enough time to pursue encountered information, even though they were not working to a strict deadline (Makri et al., 2017). Non-interesting or useful encounters are often perceived as a negative distraction (Dantonio et al., 2012; Waugh et al., 2017) and, sometimes, as time wasted (Yadamsuren and Heinström, 2011). Encounterers face a time investment trade-off (Dantonio et al., 2012), where the more time spent undirected browsing, the greater the likelihood of experiencing IE but, as encounters are not guaranteed, the greater also the likelihood of 'wasting time.'

Another influencing factor is how *task-focused* the encounterer is (how willing they are to switch from the active seeking to the passive encountering task; Erdelez, 2000). When highly task-focused, encounterers are more likely to consider IE a negative distraction (Yadamsuren and Erdelez, 2010) that can result in 'sidetracking' (Erdelez, 1999) and loss of focus (Yadamsuren and Heinström, 2011), taking them away from their original information-seeking path and potentially 'sucking them into' a cycle of exploration (Yadamsuren and Erdelez, 2010). People are more likely to be receptive to encountered information when they are not task-focused (McBirnie, 2008; Jiang et al., 2015).

The interplay between active seeking and passive encountering creates a *tension* (Kuhlthau, 1993) between staying task-focused, *"unwilling to give up the reigns of the search"* and being willingly 'led astray' (Toms and McCay-Peet, 2009, p.199-200). This has been termed the *seeking-encountering tension* which, on one hand entices encounterers towards the relatively high-risk, high-reward activity of exploring encountered information and, on the other, draws them back towards the relative safety of goal-directed information-seeking (Waugh et al., 2017). Waugh et al. highlight that weighing up perceived cost versus benefit is difficult as *"the nature and magnitude of the benefits remain unknown until resources have been invested in harvesting them"* (p.278). They argue IE *"can be seen as a mixed blessing… on one hand, it can tempt people to explore, on the other it can create a degree of chaos, encouraging information avoidance"* (p.279).

Heinström (2006) found *"the most impenetrable barriers against unexpected discoveries seem to be indifference, boredom, negative emotionality*, idleness and fast surfing"* (p.591). Other factors that can influence IE include: information-related factors such as *type*, *visibility*, *source* and perceived *relevance* and *quality** (Jiang et al., 2015), environmental factors such as *website usability and functionality.** (Jiang et al., 2015; Erdelez, 2000) and user-related factors such as *current emotional state**, *information-seeking expertise*, *curiosity* level and *intentionality** (drive to stay focused on original information-seeking goal; Jiang et al., 2015, or conversely, willingness to step away from the active information-seeking task; Erdelez, 2000). While these authors do not distinguish between factors that can *disrupt* the IE process once it has started and those that can *prevent* it from starting in the first place, asterisks denote potential disruptive factors.

Existing research has provided a broad understanding of factors that can influence IE. However, a detailed understanding of factors that can disrupt the process after it has begun and their influence on the process (*when and why* they cause disruption) is lacking.

Methodology

Data collection

"Observing serendipity has proven very difficult" (McCay-Peet and Toms, 2015, p.13), highlighted by methodological difficulties in prior studies (e.g. Erdelez, 2004; Toms and McCay-Peet, 2009) which have used artificial environments and researcher-chosen, goal-directed tasks. Our approach, which refined a method previously used to observe IE on the Web (Makri et al., 2015), used a *naturalistic* environment and *participant-chosen* (often exploratory) tasks.

Fifteen participants, aged 22-60, were recruited from the researcher's personal and professional contacts by word-of-mouth and via social media to participate in observations and follow-up interviews. Most were postgraduate students or working professionals. All reported to find information on the Web several times weekly. Each session was conducted in a quiet environment of the participant's choice (including coffee shops and the university library), using the researcher's laptop. Although the setting was controlled, participants were requested to behave as naturally as possible, as if the researcher was not observing, as this would maximize the chance of obtaining useful findings.

Participants were asked to spend around thirty minutes finding information on a self-chosen topic using websites of their choice, while thinking aloud; explaining what they were doing and why (i.e. their information interaction behavior and rationale). The aim was to encourage participants to choose information-seeking tasks that were as naturalistic as possible and websites they would normally use to undertake those tasks. They were told: topics must be based on a real need, could relate to their studies, work or everyday life, be anywhere from broad to specific, they could change topics during the observation, and it did not matter if they found interesting or useful information on their topic. They were asked not to access any potentially offensive or obscene information. They were asked to briefly explain their chosen topic before beginning. These instructions aimed to strike a delicate balance of not biasing towards highly goal-directed information-seeking (at the expense of engaging with encountered information) and not biasing towards IE specifically (which might make information encounters, and behavior in response to them artificial).

As priming participants on the study's IE focus could potentially result in 'staged' IE behavior and therefore artificial responses to encounters, based on advice from Bogers et al. (2013) and our previous experience of observing IE (Makri et al., 2015; Waugh et al., 2017), participants were initially briefed the study was examining how they found information and, towards the end of the follow-up interview, told about the specific disruption focus. To further avoid bias, the researcher only intervened when wanting to test her assumptions or elicit more detail about their behavior or rationale. This involved asking *what* and *why* questions (e.g. 'what did you just do/are you doing now?' 'why?'). Screen and audio recordings were made, and notes taken on potential encounters and disrupting factors, to discuss in the follow-up interview.

Follow-up interviews focused on better understanding the observed IE episodes and associated disruption. To determine if IE occurred, the researcher asked participants if they encountered any interesting, useful or potentially useful information unexpectedly, eliciting details. To better understand their information-seeking goal (or lack of) in relation to the information encountered, she asked participants if they were looking for particular information at the time of the encounter and, if so, what.

To better understand the disrupting factors, she asked if participants examined, explored or otherwise followed-up on the encountered information and their reasons. If yes, she asked if the information was ultimately useful and why. If no, if anything had held them back. In both cases she asked if they felt the need to return to their original information task, and why.

Where participants did *not* disrupt their encounters, the researcher asked if they had disrupted IE in the past (all had). She then asked them to discuss in detail a memorable example, based on the Critical Incident Technique (CIT) (Flanagan, 1954), using the Web as an aide-memoire without trying to re-create their example. The CIT is particularly useful for eliciting detailed examples and therefore rich data. Directly observing IE, let alone disruption to the process is difficult due to its unexpected nature. Therefore, the inclusion of a CIT component to triangulate observations allowed disruption to the IE process to be directly observed where possible and for memorable accounts of disruption to be elicited otherwise. This approach resulted in theoretical saturation once fifteen participants had been recruited.

Data analysis

The observation and interview data were de-identified and anonymized upon transcription. Participants provided informed consent for this data to be reported in academic publications and were offered to review their anonymized transcript and accompanying screenshots. Any screenshot content which could potentially be used to identify participants was obscured.

An inductive Thematic Analysis (Braun and Clarke, 2006) was conducted, where disrupting factors and rationale for their disruption were identified. Although influencing factors from the literature (e.g. time) were used as sensitizing concepts, themes were identified inductively along with related properties. For example, the properties 'task urgency' and 'task importance' were associated with the theme 'reluctance to deviate from the goal-directed information-seeking task.' Themes were refined by reviewing the applicability of coded extracts to themes and of themes to the entire dataset. For example, the 'reluctance to deviate…' theme was originally labelled 'having a specific information goal,' but constant comparison of the data to its corresponding theme and of the thematic labels to each other resulted in all themes being presented as a 'reluctance to…' (e.g. risk dead-ends). Constant comparison also ensured analysis rigor.

While in Thematic Analysis it is common to identify main overarching *themes* and *sub-themes* within them (Braun and Clarke, 2006), a single overarching theme was identified; *caution when faced with an uncertain cost-benefit trade-off.* This theme was integral to all the factors and is central to understanding why disruption occurs.

Findings

Of the fifteen participants who encountered information during observation, five disrupted the IE process and the remaining ten provided a memorable example of disruption. Findings are split into *when* and *why* the process was disrupted. *When* is addressed by discussing examples of disrupted encounters at various stages post-noticing. *Why* is addressed by discussing factors that discouraged encounterers from examining or exploring the information and simultaneously encouraged them to return to active, goal-directed information-seeking. Due to the relatively small sample size, frequencies of disruption at different process stages are not stated or compared. Instead, following recommended qualitative reporting practice (Braun and Clarke, 2006), approximations (e.g. most, some) are used.

When the information encountering process was disrupted: Disruption examples

Most disruption to the IE process happened when participants *noticed* an informational stimulus but did not *examine* the encountered information However there was also evidence of participants *examining* the information but disrupting the process during or immediately afterwards and *exploring* the information (by conducting follow-up seeking on it) and disrupting the process during or immediately afterwards. Participants returned to their active seeking task once it became clear the encountered information was not useful. While none of the example IE episodes presented are life-changing, they all illustrate unexpectedly finding information that was (at least initially) considered interesting, useful or potentially useful. Particular examples were selected because they help illustrate the various factors

found to influence disruption. Those in this section were selected because they illustrate disruption at each stage of the IE process.

Disruption after noticing, without examining

P5 disrupted the IE process after noticing an informational stimulus, without examining the encountered information itself. He was looking for information on business accelerators in London for a work task with an approaching deadline. He Googled 'accelerators London' and clicked on 'Official list of London business accelerators and incubators,' which took him to a blog on 'HubbleHQ' listing London accelerators. He clicked on a listing for the 'Seedcamp' accelerator, followed a link to a list of the start-ups Seedcamp funds and unexpectedly encountered information on the start-up 'Beagle:' "*Oh wow! Sorry...I've just seen they have a start-up called Beagle where they use artificial intelligence to read contracts, highlight key information and provide immediate understanding - wow! Someone was talking to me about that the other day!"* He hovered over the link to Beagle's website (figure 2) but did not click on it, instead continuing to look through Seedcamp.

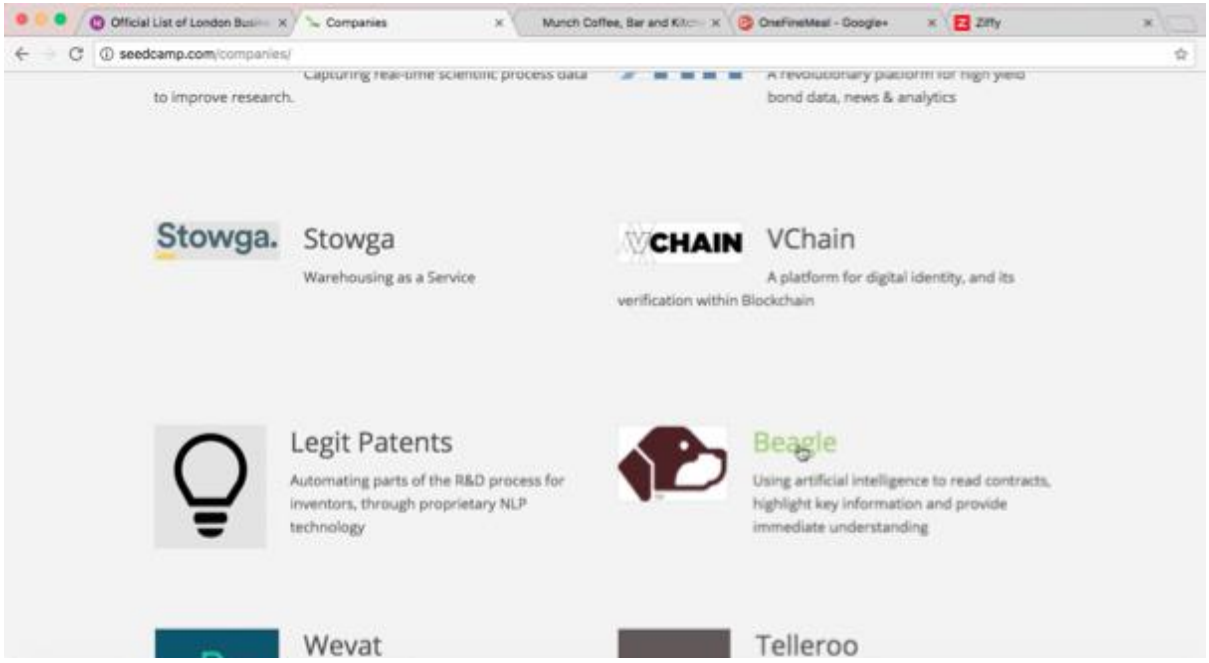

Figure 2: The 'Beagle' link P5 did not click on

Rather than examine the website or look for more information on Beagle, P5 continued with his goal-directed task of seeking information on London business accelerators, citing his impending deadline. He disrupted the IE process due to reluctance to invest *time* in engaging with the encountered information and reluctance to *deviate* from the goal-directed information-seeking task. These and other disrupting factors are discussed later.

Disruption after examining, without exploring

P12 disrupted the IE process shortly after suspending the active seeking task to examine the encountered information. She was looking for an overview of cognition for her eye-tracking dissertation. She stated the vague goal of finding 'a scientific argument' on cognition but was unsure which keywords to use. She encountered information she subjectively considered interesting, and unexpected (even though it was cognition-related).

She Googled 'new scientific research in cognition' and clicked on 'Brain and Cognitive Sciences,' which took her to a news article listing page on MIT News (figure 3). She noticed 'How we Recall the Past' and said *"oh, that's interesting. 'Neuroscientists discover a brain circuit dedicated to retrieving memories.' That looks good. I'm going down a rabbit hole! This is completely off track. It's not eye-tracking, it involves a totally different part of the brain."* She opened the article in a new tab and briefly scanned it. She said *"maybe I'll read this later, so I'll save it for now. Let's not get too distracted."* She

saved the article link and resumed looking through the article list. She disrupted the IE process due to reluctance to invest *time* in examining the encountered information in detail upon encounter and reluctance to engage in an information exploration cycle.

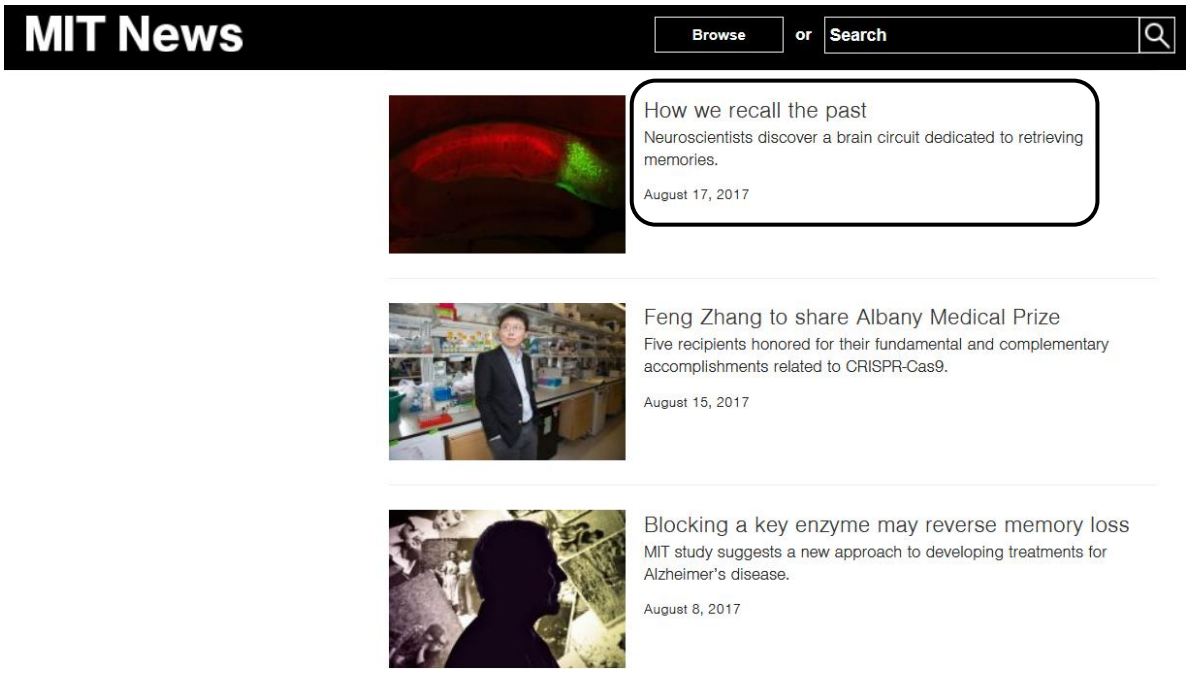

Figure 3: The article P12 scanned but did not examine in detail

Disruption after follow-up seeking

P4 disrupted the IE process temporarily before examining the encountered information, and permanently after deciding it was not ultimately useful by follow-up searching. She was researching places to visit in Wales. She Googled the Arriva Trains Wales website, found a Welsh railway map and noticed 'Roman Bridge' station (figure 4). She thought Roman Bridge could be interesting based on her interest in Roman history, stating this 'felt like serendipity' because it seemed 'specific to her' and unexpected. However, she was concerned immediately following-up might take her *"down a rabbit trail."* She noted *"when I was looking at the railway map, I was conscious there were twenty different towns, or stops, I could Google at that moment to figure out if they were useful. And I didn't pursue that one because I was afraid of losing my track..."* After noting several towns of interest from the map, she conducted follow-up searches on some, including Roman Bridge, noting *"it's just called Roman Bridge and it's a railway station. I don't think there's even a bridge. It doesn't look very exciting. There's no village, not even a pub. Well I'm not going there!"* She temporarily disrupted the IE process due to reluctance to *multitask* and *risk dead ends*. She disrupted it permanently when it became clear the encountered information was not useful, voicing frustration at having invested *time* following-up on the encounter: *"I see this cool Roman Bridge station that I wanna visit and then I spend time looking into it, only to find out it's not anything interesting."*

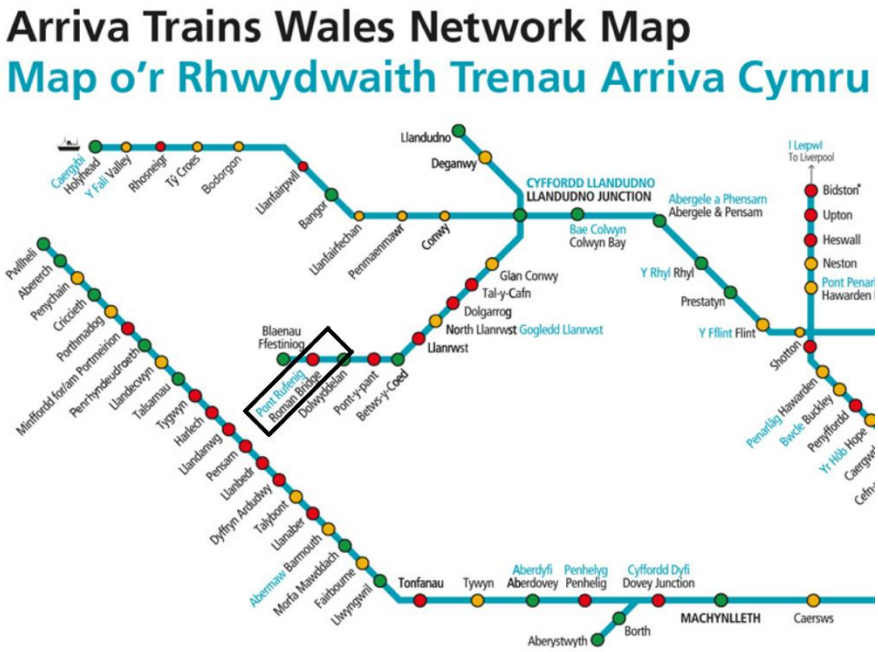

Figure 4: The Welsh railway map P4 examined

Why the information encountering process was disrupted: Disrupting factors

Several strongly inter-related factors that disrupted the IE process were identified (from the observations and memorable examples of disruption). These include reluctance to: invest *time* and *effort* in engaging with encountered information, *deviate* from the goal-directed information-seeking task in which the encounter was embedded, *multitask*, risk *dead ends*, *engage in an information exploration cycle* and *trust emotion over logic*.

Reluctance to invest *time* and *effort* in engaging with encountered information

The perceived importance and urgency of the active information-seeking task meant participants sometimes prioritized it over examining or exploring encountered information. This manifested in participants disrupting IE due to perceived lack of time. Perceived lack of time has also been identified as a reason for *disengagement* with information (O'Brien and Toms, 2008) and a key barrier to active seeking as it constrains search breadth and depth (Savolainen, 2006). The follow-up interviews revealed minimal evidence of task time constraints influencing these perceptions. While P5 mentioned he might have examined the Beagle start-up information he encountered (figure 2) if he was at home (a comment participants also made in previous studies; André et al., 2009; Toms and McCay-Peet, 2009), he stated his reluctance to invest time in engaging with the information was primarily due to the importance of his original seeking task (on business accelerators) for his work, and the impending deadline.

P15 explained, in the absence of time constraints, *"obviously you've gonna follow the most interesting thing. If I had a deadline, I wouldn't go off-topic because I know I have specific information to find."* Referring to the MIT News article she encountered, which she saved but did not examine in detail at the time, P12 thought to herself *"stay focused and go back to what you're looking for. I'm not doing this for fun, I've got time pressures."* Time constraints could therefore serve as a 'fun filter,' encouraging productivity.

Participants voiced concern that examining and follow-up seeking are potentially time-consuming, with no guaranteed reward, echoing the investment trade-off identified by Dantonio et al. (2012). P11 stated when encountering information *"usually what you find is really interesting, so you can find yourself going on a tangent for ages. If you want something done quickly then you don't want to look at unrelated information…You don't get anything done and it wastes time."* Participants were discouraged from investing time and effort engaging with encountered information due to uncertainty surrounding how long it would take to yield interesting or useful information, if at all.

Self and externally-imposed deadlines contributed to the perception of lack of time, supporting previous findings (McBirnie, 2008; Toms and McCay-Peet, 2009; Jiang et al., 2015):

> *"Deviating from your goal is a bad thing when you're on a schedule… when you've allocated 2 hours to finish this task and find yourself looking at sightseeing options in Paris"* (P3).

Even without specific deadlines, participants sometimes refrained from engaging with encountered information (supporting O'Brien and Toms, 2008; Makri et al., 2017); P4 preferred capturing encountered information for later review as immediate follow-up "*would take too long."* P16 described looking for weekend activities and, while viewing a movie list, discovered the name of an actress she liked. She follow-up searched, spending *"about 20 minutes reading about her personal life, which was not related to my goal."* She stated: *"I always tell myself 'this is a trap, go back!' You get stuck in a trap because it's very easy to spend lots of time on searching."* (P16).

Participants experienced negative emotions when they fell into this 'trap' by spending time examining or exploring encountered information only not to find it useful. P16 regarded going 'off-topic' *"not entirely a waste of time, but not that productive"* and commented *"most of the time I end up with the feeling of guilt."* Guilt has been associated with information disengagement (O'Brien and Toms, 2008). P3 felt frustrated when he encountered a forum post on breathing exercises (figure 5) that did not end up useful while searching for information on horn mouth embouchure (how to correctly position the instrument on the mouth), considering the encounter *"a waste of time."* He also stated exploration without payoff *"sometimes makes me feel bad even if I'm not time-restricted. It makes me feel like a distracted person, like I'm not able to stick to one thing."*

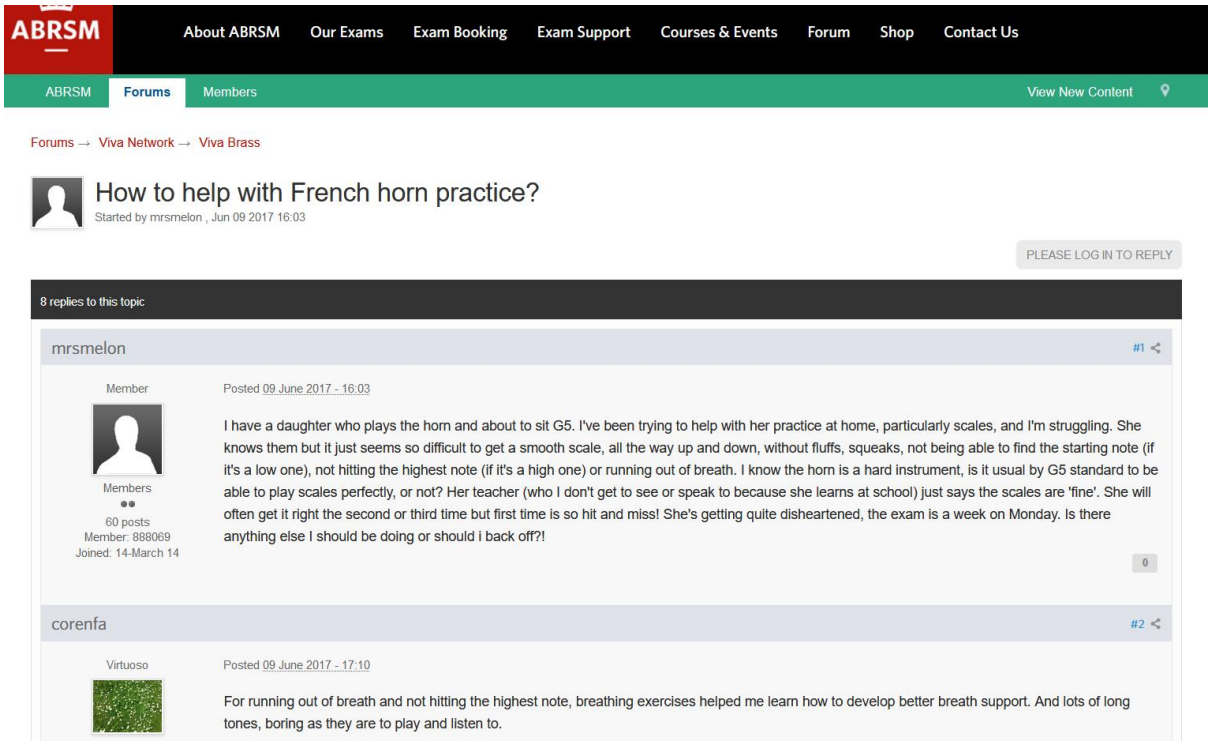

Figure 5: The forum post P3 read

While deadlines and time pressures have been found to negatively influence IE (McBirnie, 2008; Toms and McCay-Peet, 2009; Dantonio et al., 2012; Jiang et al., 2015) and engagement with information in general (O'Brien and Toms, 2008), these findings explain *why* they disrupt the IE process.

Reluctance to *deviate* from the goal-directed information-seeking task

Reluctance to deviate from the goal-directed information-seeking task in which the encounter was embedded was implicit across all factors, and identified explicitly. Participants were most reluctant to

suspend active tasks they deemed particularly *important or urgent*. As explained by P15, *"if your topic wasn't important to you in the first place then there are no negative feelings when you go off-topic."* This highlights the duality of IE as sometimes a positive, other times a negative distraction from the active seeking task. P5 identified the urgency of the active task as a reason for not examining the Beagle information further. When asked what factors contributed to him staying on topic, P5 replied "*the urgency of the task, because I know I have limited time. I have to get something done for tomorrow.*"

When the active task was considered urgent or important, encountered information was usually regarded as a negative distraction, as it encouraged goal-divergence. P6 was reluctant to engage with encountered information when undertaking important goal-directed tasks. She regarded negative distraction as mentally draining, 'harming her brain' by exhausting her before she can achieve her goal:

> *"There might have been even more serendipity when I was searching, but I deliberately ignore that because I get distracted and it harms my brain. Distraction means I spend a lot of mental energy just reading about stuff and I don't know when to stop. Then I'm exhausted and the things I needed to be done are not done. It's a lose-lose situation"* (P6).

The importance of achieving a specific information goal was highlighted by P10, who received a notification from the BBC News mobile app, but almost immediately followed a link to a recommended related article, struggling to return to the original article. She noted *"I get deeper and deeper into other bits of information but not necessarily what I want at that time. So I'm filling my brain with stuff that is useful and interesting, but not for that moment. And then I haven't achieved what I set out to do."* Referring to this example, she commented "*when I explore unexpected information immediately, it makes me feel nervous because I feel I'm being too impatient."*

Participants were concerned about deviating from goal-directed tasks because they thought they might *forget their original goal* or *forget how to return to their original task*. P10 does not explore encountered information when she has a specific goal because she gets *"worried I'm gonna get in a muddle and forget what I set out to do."* P13 forgot to return to her active task of looking for new work shoes. She Googled retailer 'Topshop,' and was about to visit its website when she encountered an article under 'top stories': 'Topshop bosses out of fashion in Arcadia shake up' (figure 6). She stated this was useful as she works in retail and likes to follow developments. She read the article then noticed another interesting article about supermodel Kate Moss becoming editor of Vogue magazine. She did not resume looking for shoes. When asked why not, she said *"I forgot...I got distracted, didn't I? I wanted to shop and then didn't even get to look at what I wanted to. I would have rather found the shoes than read about Kate Moss."*

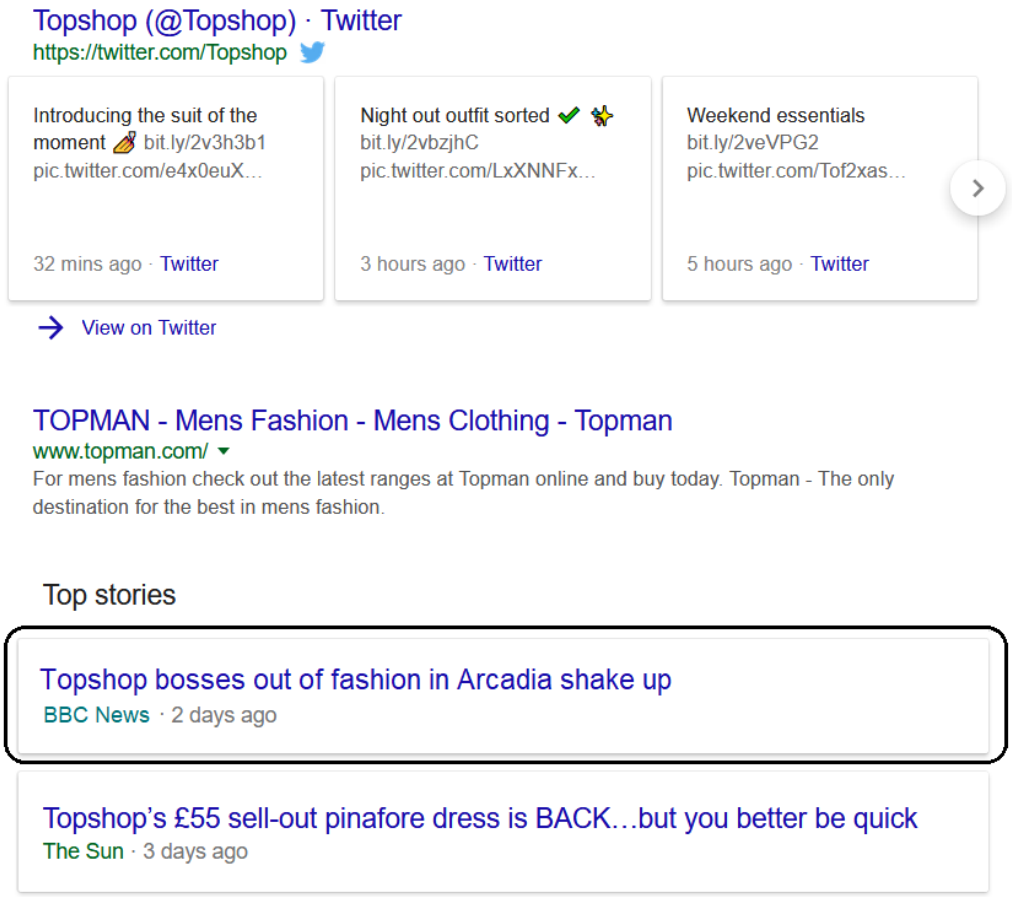

Figure 6: The news article P13 encountered

Some participants worried about IE taking them so far from their active tasks they might forget how to return to them. P9 commented *"you often forget exactly where you were, and you want to go back, but can't."* When P11 interrupted looking through a list of attractions in Tamaris-sur-Mer on TripAdvisor to view an encountered listing of a holiday villa, she commented *"it was more effort going back to the list than finding what I needed in the first place."*

Reluctance to deviate from the goal-directed seeking task relates to having a *specific information goal*, which has been found to influence IE in physical libraries (Waugh et al., 2017), to being highly task-focused (Yadamsuren and Erdelez, 2010) and to having high 'intentionality' to stay focused on the active seeking task (Jiang et al., 2015). While this theme has been previously discussed in the context of IE, these findings provide insight into *why* it can disrupt IE.

Reluctance to *multitask*

Reluctance to multitask also disrupted IE. IE necessitates handling the active seeking and passive encountering tasks simultaneously, potentially leading to disorientation and loss of control: both important facets of information engagement (see Webster and Ahuja, 2006; O'Brien and Toms, 2008). After encountering a holiday villa on Tripadvisor, P11 contemplated returning to her active task of finding attractions in Tamaris-sur-Mer *"straight away"* and disrupted IE without examining the encountered information as she felt she *"can't do too many things at once and like to just focus on one task at a time."*

The excitement and potential reward of encountered information enticed participants to examine or explore it, creating an additional task. However, the additional cognitive demands can lead to *disorientation* when task-switching, which negatively influences information engagement (Webster and Ahuja, 2006). To mitigate this, some participants captured encountered information for later, to finish the active seeking task undisrupted.

Some participants felt *loss of control* when they encountered information, as finding it was unplanned and therefore presented a surprise potential exploration path. It also presented a dilemma concerning whether to risk no payoff and potential disorientation for an unknown, but potentially exciting reward. When asked if IE was a good way of discovering information, P3 replied "*I think it's a good way. But you need to know how to control it. You need to know when to stop."* P3 recalled frequently aiming to find a certain number of papers on Google Scholar, but IE causing his target to expand. He described the dilemma of engaging with encountered information as "*like an itch. You want to follow it and it seems interesting and promising, but you can't tell."* This dilemma is also reflected in prior work on information engagement; O'Brien and Toms (2008) found users often enjoyed being *"carried away from their original task"* (p.11) and consider *willingness to explore* encountered information, through follow-up seeking, an indication of users' engagement. However, they also emphasize the importance of users feeling *in control* of their tasks for engagement.

Multitasking is important during Web search (Spink et al., 2006) and although the cognitive implications of information-*seeking* have been widely discussed (Ford et al. 2002; Spink and Cole, 2005), this is not the case for IE. Information tasks can strain cognitive resources, including working memory (Gwizdka, 2010). IE can be particularly resource-intensive; working memory may be required to remember the active seeking goal, the progress made towards it and the point during active seeking it was suspended. Also, potentially to recall background knowledge to support insight creation and to navigate the (possibly unfamiliar) environment. This can discourage engagement with encountered information in favor of continuing with the less cognitively-demanding active seeking task.

Reluctance to risk *dead ends*

Disruption also occurred due to reluctance to risk dead ends. While encounters could be rewarding, taking participants in exciting new directions, they could also lead to dead ends, with no reward. P1 reached a dead end when looking for information on endurance when playing the horn. In a blog post on orchestra endurance, he noticed a link to another post ('How not to Get on in an Orchestra,' figure 7). As P1 is a conductor, he thought the post might provide useful advice but soon realized he had previously read it, so followed-up by Googling 'bad conductors.' He read some forum posts but, as they were not useful, disrupted the IE process by returning to his original search on 'horn stamina.'

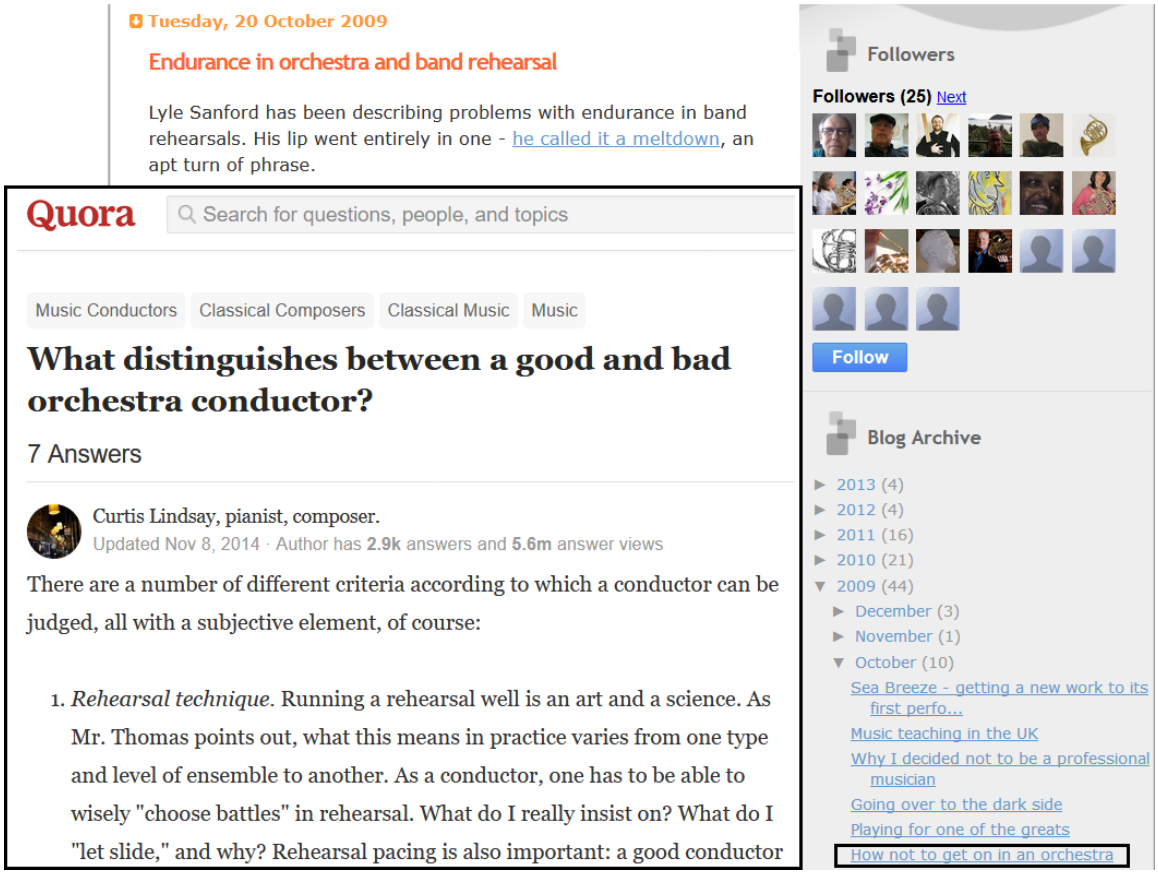

Figure 7: The blog post P1 encountered (right) and follow-up information found (left, inset)

Uncertainty surrounding difficulty in predicting whether an encounter might be productive or result in a dead end discouraged some participants from engaging with encountered information, as explained by P9, who used the analogy of exploring a physical landscape:

> *"It's the uncertainty. You don't know about it, so you're not sure. Say you're hiking and a map tells you there is something else to see over there. Do you want to take the risk and go off that direction, where you could get totally lost and have to return to where you were?"* (P9).

Participants expressed frustration determining their place in the active seeking task to return to after reaching a dead end. P12 stated "*I go down rabbit holes and then sometimes I come to a dead end and get frustrated because I have to come back up."* Difficulty returning was regarded as a double-penalty, as it consumed additional time and effort and discouraged some participants from following-up on encountered information. It compounded with a feeling of having wasted time by pursuing encountered information that resulted in a dead end:

> *"I often forget what I was doing and think 'I just spent 3 hours doing nothing.' Then I don't know where I am and want to go back but can't."* (P10).

Dead ends are common in both IE and active seeking (Godbold, 2006), however, reaching a dead end during IE can potentially cause more frustration as the unsought, surprising nature of encountered information can raise encounterers' hopes of interestingness or usefulness. While dead ends have been identified as drawbacks to IE (Hoeflich, 2007; Waugh et al., 2017), this study provides insight into *why* they can disrupt the process.

Reluctance to *engage in an information exploration cycle*

As exploration can result in dead ends, reluctance to engage in an exploration cycle also sometimes discouraged participants from following-up on encounters. Encountered information had an exciting allure, which P6 described as a reason to disrupt IE and return to active seeking:

> *"I can be very easily distracted by shiny things, so I try to keep focused on the activity"* (P7).

As follow-up seeking often has a loosely-defined goal, there was concern this could lead to a cycle of open-ended exploration and involve time and effort investment with no guaranteed payoff. P12 identified 'missing out' on information from the active seeking task as an opportunity cost of exploring encountered information, stating "*if you get distracted a little bit too much, other things can happen from that distraction and you can miss out on something from before."*

Related to excessive time/effort investment, deviating from a goal-directed task and reaching dead ends, there was concern encounters could encourage drifting far off-topic – a concern also noted in a social media IE context (Dantonio et al., 2012). P6 reported "*consciously trying to stay as much on my route as possible"* as *"it's very easy to get distracted and click on all the links on the page and then all the links on the next page. Then it's 3am and you're reading an article about worms. Why? Nobody knows."* P10 was looking for suitable plants for a shady garden and encountered information on flowerbed preparation with plants of varying textures. When asked why she returned to her active task instead of examining this information in detail, she stated *"I would have got a bit carried away with that because texture is a very wide area and that might have taken me too far away from plants for shade."*

As with reluctance to multitask, concerns were raised over losing control, as participants could quickly become engrossed in exploration and lose track. Some were concerned they would forget their active seeking task or how to return to it (see '*reluctance to deviate…*'). For example, P4 forgot her active task during an exploration cycle. She was looking for activities in London and encountered information on an art-deco-themed cinema. She browsed the movie listings but was unsure if she liked any. So she copied one of the movie titles, intending to watch the trailer on YouTube. But on YouTube she noticed 'The Daily Show' in the 'recommended' list, watching it instead. She was only reminded of her active task when she noticed the still-open cinema tab:

> *"I had completely forgotten what I was supposed to be doing. If I had remembered, I would had gone back. But I usually need a trigger to remember. Especially because that was kind of a chain task"* (P4).

While negative task distraction has been found to influence disengagement with information (O'Brien and Toms, 2008) and getting 'sucked in' to a chain of information exploration has been noted as a concern among online news readers (Yadamsuren and Erdelez, 2010), these finding explain *why* this can disrupt the IE process.

Reluctance to *trust emotion over logic*

Finding unsought information sparked excitement and positive emotions, which some participants were reluctant to allow to encourage them to engage with information they might not have otherwise. They did not want to get 'caught up' by allowing the unexpectedness of the encounter and appeal of the information to influence their thinking and behavior. P13 'resisted' purchasing discounted products encountered online, stating she was occasionally *"guilty of quick wins"* which she would later regret. P15 felt 'annoyed' after purchasing an unenjoyable videogame based on an encountered YouTube trailer, stating *"it was impulsive… I pre-ordered when I wouldn't normally buy the game. But I ended up not liking the genre. It made me annoyed."*

P16 applied for a French travel visa and needed to submit a return itinerary to France in support. She did not want to fix an exact date until she knew her application had been successful. Therefore, she intended to find the cheapest flight from London to Paris but Googled the more ambiguous terms 'cheapest ticket to Paris.' This returned results for low-cost flights, but also National Express coaches (figure 8) which altered her to the possibility of coach travel. She examined the site and, enthused by the idea of an overnight road journey to Paris, booked tickets on convenient dates (rather than the cheapest tickets, to discard). In hindsight, she regretted the decision, forfeited the tickets and blamed the encounter for influencing her emotions and resulting in an illogical decision, commenting *"in my*

experience, I notice something eye-catching and I'm like 'yes, I'll buy it.' Then I later discover I don't need it."

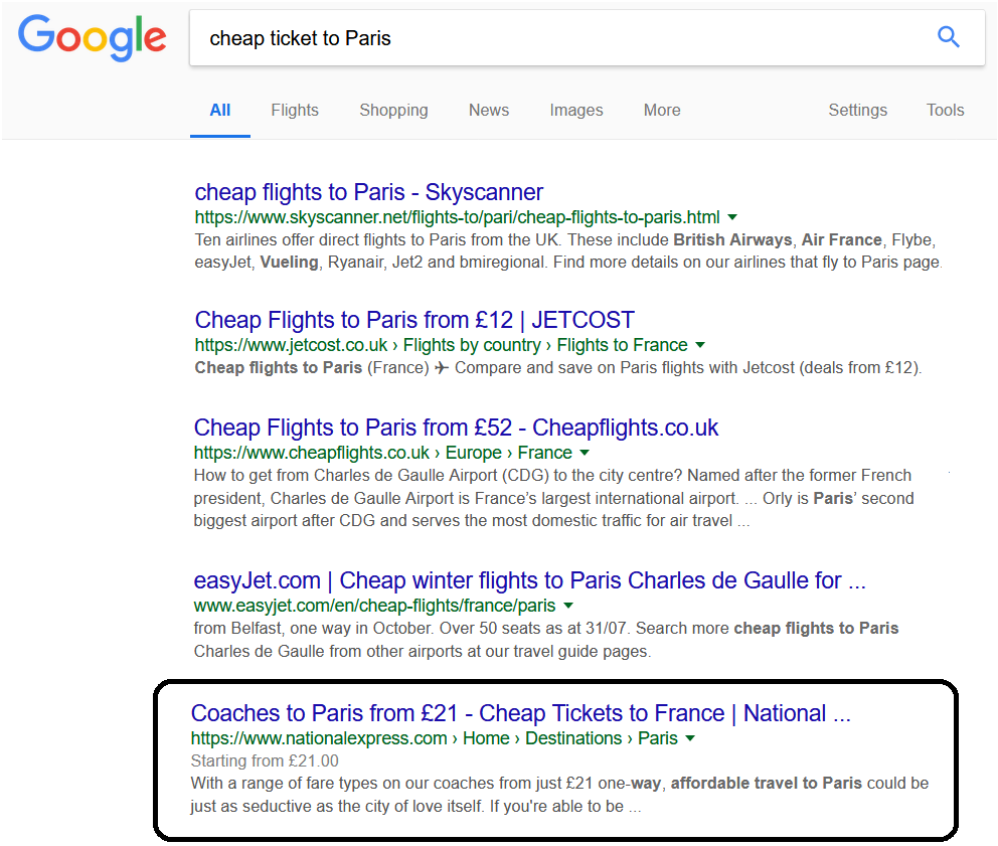

Figure 8: The National Express coach Website P16 encountered

P16 explained her experience by suggesting serendipity appeals to emotions, rather than logic and that encountered information can result in temptation that is satisfying only in the short-term:

> *"Serendipity somehow flirts with you. It touches your soul and says 'this is shiny.' It's tempting. Serendipity appeals to your emotions rather than your logic. It might satisfy you for a short period, but it's often a quick reward"* (P16).

While prior research has found IE can trigger positive emotions (Erdelez, 1999; Yadamsuren and Heinström, 2011), we are unaware of any previous findings that highlights positive emotions can encourage encounterers to trust emotion over logic when making engagement decisions.

Discussion

Importance of findings

This research enriches understanding of *when and why* disruption to the IE process occurs and highlights that negative emotionality is often associated with what has (until now) been mostly described as an inherently positive process. Disruption mostly happens after noticing an informational stimulus but without examining it in detail, but also occasionally during or immediately after examination or follow-up seeking. This suggests encounterers often decide to ignore an encountered stimulus immediately after noticing it. Even if they decide to examine the encountered information or conduct follow-up seeking, they 'cut their losses' if it becomes apparent the information is not interesting or useful. This is the first known study to directly observe disruption to IE, paving the way for understanding other aspects of IE through observation (e.g. process variation in different task or environment contexts).

The major contribution is a detailed explanation of *why* disruption occurs, through the identification of inter-related disrupting factors. All relate to the integral theme of *caution when faced with an uncertain*

cost-benefit trade-off. This highlights that uncertainty and cost-benefit trade-offs, concepts integral to information-seeking (Kuhlthau, 1993; Pirolli and Card, 1999), are also key for explaining disruption to IE.

It is difficult to estimate the *time* and *effort* required to examine or follow-up on encountered information by *deviating* from the active goal-directed task, as the existence, nature and magnitude of the benefit is often not apparent until after a commitment is made. There are also risks of no benefit - of the encountered information not ultimately being interesting or useful, resulting in a *dead end*. Even with productive encounters, there is a risk of disorientation from *multitasking* or *engaging in exploration cycles*. This can result in encounterers forgetting (how) to return to the active task. In non-productive encounters, disorientation can act as a double penalty by requiring extra time and effort to retrace previous information-seeking steps. There is also the risk of getting 'caught up' by positive emotions associated with the encounter and *trusting emotion over logic*, investing time/effort engaging with information that is not ultimately useful. Demonstrating caution by refraining from engaging with encountered information and instead resuming goal-directed seeking may reduce perceived uncertainty and risk by increasing perceived control. While the impact of these factors on information-seeking has been widely examined, and some have been found to influence IE specifically, *why* they disrupt the IE process has not been previously discussed in detail.

This research emphasizes decisions on whether to engage with encountered information are not made in isolation, but relative to the perceived urgency and importance of the active information-seeking task in which the encounter is embedded; if the seeking task is perceived as more urgent or important, encounterers may sacrifice potential rewards by staying task-focused. If not, encounterers may go 'down the rabbit hole' with less at stake. While this is most apparent for *time* and *effort*, as these are resources that can be 'better spent,' it applies to all factors. For example, reluctance to *risk dead ends* or *engage in exploration cycles* not only stemmed from concern over wasted time and effort, but also (and simultaneously) hope that active information-seeking would be more failsafe for finding useful, albeit likely different, information. Therefore, encounterers do not just balance the potential risks and rewards of IE but do so relative to less risky (but potentially not so rewarding) information-seeking.

Avoiding uncertain risk allows encounters to feel more in control of their resources (*time, effort*) and the trajectory of their active seeking task. Optimizing cost versus benefit is not straightforward when encountering unsought information; if interesting or useful it can propel encounterers in new, exciting directions for seemingly little investment. Therefore, engaging with encountered information can be a way of optimizing this trade-off. However, if considerable time and effort is invested but the encountered information is not ultimately useful, *not* engaging with it would have been optimal. The decision is in many ways a leap in the dark. It is potentially high-risk-high-reward, but also potentially non-rewarding. This may explain why several participants opted to spend their limited time and effort on less uncertain active seeking. Importantly, however, the IE process was not always disrupted; several participants completed the process and were rewarded as a result.

If humans evolved by optimizing resource acquisition (Pirolli and Card, 1999; Sandstrom, 1999), and employ the principle of least effort when acquiring information (Bates, 2002), they will try to minimize cost and maximize benefit when encountering *and* seeking information. However, passive encounters present special difficulties; both the potential risks and rewards are uncertain at the time of the encounter and may only become fully apparent *after* the risk has been taken (Waugh et al., 2017). While the costs may be more tangible than the potential benefits, they also might be over or under-stated. Encountered information can hold unfulfillable or hidden promise; it may appear potentially useful but not turn out so, or it may not seem useful upon encounter (or its usefulness may not be immediately apparent) but turn out to be. This makes the cost-benefit judgment of deciding whether to engage with encountered information more uncertain than with sought information and may explain why encounters can be cautious when faced with the 'blind gamble' of an uncertain cost-benefit trade-off.

Limitations and future work

This study was not immune to the *"many methodological challenges"* (Jiang et al., 2015, p.1140) associated with observing IE. In controlled IE settings, risk of task and environment influence on behavior can be minimized, but not removed entirely. The only evidence of influence was P5's comment that he might have examined information further if he was at home and did not have an impending work deadline. While follow-up interviews probed participants' reasons for disruption, providing the

opportunity to discuss influencing factors, the 'halo effect' may have prevented some participants from declaring perceived influence. As asking overtly may itself encourage responses that downplay any influence, future studies could ask subtle, direct questions such as 'do you think you might do anything differently if you were at home or had more time?' It would also be useful to ask participants not only about the nature, but also the *importance* of their self-chosen information-seeking tasks, to provide insight into the potential cost-benefit trade-off of disrupting the task.

Although the task instructions emphasized the possibility of choosing a topic 'anywhere from broad to specific,' participants selected directed and semi-directed tasks and used Google as it was their usual starting point for 'finding information.' This limited the possibility of observing disruption during active but *undirected* seeking. Future studies might restrict environment type to those that readily support finding information without a particular goal (e.g. current awareness environments such as social media feeds, online news sites etc.).

Direct observation also creates a *passive observation paradox*; as passive information tasks cannot be readily undertaken on demand and there must be concrete activity to observe, the requirement to complete an observable task may bias users (consciously or unconsciously) towards active tasks. IE during active seeking is therefore easier to observe than during passive acquisition (e.g. information shared by others or received through push-based alerts/notifications). IE during passive acquisition could be examined through self-reported approaches.

Although all fifteen participants encountered information during the study, only five disrupted the process. Instead of providing a 'live' example, the remaining ten provided a memorable *prior* example of disruption. While this combined observation and interview approach provided methodological triangulation and theoretical saturation, future research (with additional resources) might observe a greater volume of examples. It is also possible to collect and probe disruption examples in a diary study, with follow-up interviews.

Future studies might identify additional factors or sub-factors influencing disruption or examine specific factors (e.g. dead ends) in more detail. They might further examine the nature of the negative emotionality associated with information encountering (e.g. encountering-specific uncertainty, guilt or disappointment). They might also investigate the seeking-encountering tension specifically, focusing not only on how factors pull encounterers back (disrupt the process), but also push them forwards, encouraging engagement with encountered information when faced with an uncertain cost-benefit trade-off.

Design suggestions

To make it easier to decide whether to engage with encountered information, digital information environments could augment the placeholding function of tabs to better support *'parking' encountered information* until users are ready to engage with it. It is important to provide sufficient context by capturing more than the encountered information itself, such as the informational stimulus that triggered the encounter (which can also support returning to the active seeking task) and any follow-up seeking conducted. Supporting tab groupings, or tab timelines (perhaps partly-integrated with the browser history) are potential ways of achieving this and might encourage encounterers to *deviate* from the active seeking task when not under *time pressure*, potentially easing the cognitive burden of *multitasking*. Placeholding can also help remind users of their active seeking task and help them return to where they had got to easily after a productive encounter, or reaching a *dead end*. It could encourage *multitasking* and *engaging in exploration cycles* and reduce concern over disorientation. Placeholding could be semi-automatic, or users could mark pages or content from the active seeking task to return to post-encounter.

Search environments could allow users to *dynamically adjust the degree of semantic relatedness* of query terms entered to results returned based on the importance or urgency of the active task (and the knock-on impact on users' willingness to invest *time* and *effort* to *deviate* from it). If users commit to a stance on willingness to engage, they may feel less frustrated if they reach *dead ends* or guilty if encounters are non-productive. Browse-based environments could allow users to adjust the relatedness of content presented to their stated or inferred interests. This could make cost-benefit judgments easier by allowing users to consciously decide if their 'serendipity filter' is on or off and to

prioritize rare encounters. Ironically, unexpected information encountered in 'high-relatedness mode' may be particularly interesting or useful.

To further assist users in deciding whether to engage with encountered information, environments could support *history-based highlighting* by flagging semantic relationships between information currently viewed and previous search results, or content previously viewed or captured. They might also highlight any overlap between previous search results (for searches with different query terms) and previous information viewed or captured. This aims to save *time* and *effort* in examining encountered information and make the potential benefits of *deviating* from the active task and risk of reaching a *dead end* more easily discernible. When users reach dead ends, they could indicate this, and the system could *recommend additional content* related to the encountered information (perhaps analyzing the information accessed along the dead-end path to avoid recommending further information that is not interesting or useful). Knowing there may be 'life after death' might persuade users to follow-up on encounters.

Supporting *lightweight capture and review* of encountered information would allow users to postpone examining until a less *time-pressured* or more suitable time. Review notifications could be triggered when users view results or content somewhat semantically-related to the captured information, or during 'dead time' such as while commuting, where they may be more amenable to *engaging in a cycle of exploration*. Supporting omnichannel review (particularly of information captured on desktop on mobile devices, while on the move) could facilitate this. This might encourage users to resume engagement with previously encountered information, particularly if the tool also kept a history of the user's previous (suspended) examination and follow-up activities.

Conclusion

This research investigated *when* and *why* the Information Encountering process can be disrupted. Disruption mostly occurred immediately after noticing an informational stimulus but also during and immediately after examining or following-up on encountered information. Several inter-related disruption factors were identified, all relating to encounterers being *cautious when faced with an uncertain cost-benefit trade-off.*

The uncertainty of the potential costs and benefits of engaging with encountered information makes IE more of a 'leap of faith' and quite literally a 'leap into the unknown' than engaging with sought information. But those who make this leap potentially stand to be rewarded with interesting or useful information they had low involvement in and expectation of finding. This type of information can broaden horizons and change perspectives by delivering 'unknown unknowns' - information people find interesting or useful but might not have found otherwise.

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